REMARKS

Claims 1-3 stand rejected and claims 4-19 objected to in the outstanding Official Action. Claims 1-7 and 9-19 have been amended and therefore claims 1-19 remain in the application.

Attached hereto is a marked-up version of the changes made to the specification and claim(s) by the current amendment. The attached page(s) is captioned "**Version With Markings To Show Changes Made.**"

The Examiner's acknowledgment of applicants' claim for priority and receipt of the certified copy of the priority document is very much appreciated. Additionally, the Examiner's consideration of the prior art noted in the Information Disclosure Statement submitted by applicants upon entry of the national phase in the United States is very much appreciated. However, applicants query why, when the Information Disclosure Statement mentions the Meng et al reference (U.S. Patent 5,466,965), the Examiner, in addition to considering the Meng reference, chose to submit a separate PTO Form 892 with a duplicate identification of the Meng reference. As noted in applicants' initial filing, Meng is believed to be the closest prior art and is specifically mentioned on page 3, line 9, of applicants' specification as originally filed. If the Examiner meant to refer to a different Meng reference, clarification is respectfully requested.

The Patent Office objects to the Abstract. It is appreciated that the Examiner has brought the Abstract to the applicant's attention. It is noted that the objection to the Abstract appears to be an indication that the originally filed specification and drawings (transmitted from WIPO) does not meet the formality requirements of the U.S. Patent and

Trademark Office. The Patent Office is reminded that the U.S. Patent and Trademark Office must comply with all articles of the Patent Cooperation Treaty (PCT) including Article 27. It has been held that:

"if the rule and interpretation of the PTO conflicts with the PCT, it runs afoul of Article 27 of the PCT which provides in part:

(1) No national law shall require compliance with requirements relating to the form or contents of the international application different from or additional to those which are provided for in this Treaty and the Regulations." Caterpillar Tractor v. Commissioner, 231 USPQ 590, 591 (EDVA 1986).

The Patent Office has referenced this decision in the Official Gazette dated September 9, 1986 (1070 TMOG 5).

As a consequence, the Patent Office (including the Chief Draftsman's Office) may not require Abstract changes as long as the originally submitted documents comply with the PCT requirements. Inasmuch as this specification was forwarded for WIPO, by definition, it meets the PCT requirements (it is not forwarded until it meets PCT requirements.). Therefore, the objection to the Abstract is respectfully traversed and reconsideration thereof is respectfully requested.

Notwithstanding the above, applicant has included a retyped Abstract on a separate sheet, and has added headings and subheadings to the specification.

Claims 4-19 stand objected to as allegedly being in improper form. Applicants note that these claims meet PCT requirements, and therefore under the provisions of the Patent Cooperation Treaty, the U.S. Receiving Office is obligated to examine such claims. While applicants have amended these claims to be singly dependent, examination

without issuance of a Final Rejection is respectfully requested and indeed is mandated under the terms of the Patent Cooperation Treaty.

Claims 1-3 stand rejected under 35 USC §102 as being anticipated by Meng (U.S. Patent 5,466,965). The Court of Appeals for the Federal Circuit has noted in the case of *Lindemann Maschinenfabrik GMBH v. American Hoist & Derrick*, 221 USPQ 481, 485 (Fed. Cir. 1984) that "[a]nticipation requires the presence in a single prior art reference disclosure of each and every element of the claimed invention, arranged as in the claim."

The Examiner contends that the AlGaAs barrier region 18 is the equivalent to applicants' claimed "main avalanche region." Applicants draw the Examiner's attention to the Meng disclosure at column 5, lines 39-43, which states "the aluminum gallium arsenide layer 18 is considered a barrier layer . . . ." The "main avalanche region" is defined in applicants' specification at page 7, lines 26-28, "the avalanche region is the region where the impact ionisation is significant and will extend into region (8) although it is unlikely to include all of region (8)." In other words, in applicants' specification and thus applicants' claims, the "main avalanche region" is a region where significant avalanche multiplication arises from impact ionization.

The Meng reference teaches that region 18, suggested to be the main avalanche region by the Examiner in the Official Action, is actually a "barrier region" and contains no indication that any significant avalanche multiplication arises in that region or arises through impact ionization. Thus, the Examiner's initial assumption that Meng teaches "a main avalanche region (18, AlGaAs)" is simply incorrect.

Additionally, applicants' independent claim 1 recites a "narrow bandgap region" and its proximity to the "main avalanche region" generates "within the narrow bandgap region a tunnel current which is injected into the main avalanche region." Meng's avalanche region is area 14 comprising a plurality of N-type heterojunctions. Each of the heterojunctions comprises a pair of thin films, layer 16 and barrier layer 18.

Meng specifically teaches that the width of the barrier layer is not so great as to allow any significant degree of impact ionization (see column 5, lines 43-45 and 48-50). Assuming that the Examiner meant to refer to layer 16 as Meng's main avalanche region, it is apparent that Meng includes no teaching of a narrow bandgap region. The Examiner admits that the barrier layer 18 has a wider bandgap than layer 16. There is no disclosure in Meng of the possibility, or any advantage resulting from, introducing a narrow bandgap material. The barrier layers 18 in Meng serve to accelerate the carriers, but without inducing impact ionization. There is simply no discussion in Meng of a tunnel current or any realization of the advantage or even possibility of having a tunnel current injected into the main avalanche region.

Accordingly, Meng not only fails to disclose applicants' claimed structure, it specifically teaches away from applicants' claimed combination of elements and has no apparent realization of the problem solved by applicants' invention.

As a result, unless the Examiner can point to some structures disclosed in Meng which correspond to the structures recited in applicants' independent claim 1 and their stated interrelationship, Meng clearly fails to anticipate, and indeed would appear to lead those of ordinary skill in the art away from applicants' claimed combination.

Accordingly, any further rejection of claim 1 or claims dependent thereon over the Meng reference is respectfully traversed.

Having responded to all objections and rejections set forth in the outstanding Official Action, it is submitted that claims 1-19 are in condition for allowance and notice to that effect is respectfully solicited. In the event the Examiner is of the opinion that a brief telephone or personal interview will facilitate allowance of one or more of the above claims, he is respectfully requested to contact applicant's undersigned representative.

Respectfully submitted,

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Enclosure: Abstract

VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE SPECIFICATION

Page 1, between the Title and the paragraph beginning at line 5:

BACKGROUND OF THE INVENTION

1. Field of the Invention

Page 1, above the paragraph beginning at line 8:

2. Discussion of Prior Art

Page 3, above the paragraph beginning at line 13:

SUMMARY OF THE INVENTION

Page 5, above the paragraph beginning at line 24:

BRIEF DESCRIPTION OF THE DRAWINGS

Page 7, above the paragraph beginning at line 4:

DETAILED DISCUSSION OF EMBODIMENTS

IN THE CLAIMS

1. *(Amended)* An impact ionisation avalanche transit time (IMPATT) diode device [(2)] comprising:

a main avalanche region [(10, 46) and];

a drift region [(12, 44, 48), characterised in that the device additionally comprises]; and

a narrow bandgap region [(4, 40)] with a bandgap narrower than the bandgap in the main avalanche region [(10, 46)] which narrow bandgap region (4, 40)

is located adjacent to the main avalanche region [(10,46)] in order to generate within the narrow bandgap region [(4, 40)] a tunnel current which is injected into the main avalanche region [(10,46)].

2. *(Amended)* An IMPATT diode according to claim 1 wherein the narrow bandgap region [(4, 40)] is arranged to generate a tunnel current for injection into the main avalanche region [(10, 46)] at the peak reverse bias voltage applied to the diode.

3. *(Amended)* An IMPATT diode according to claim 1 [or claim 2] wherein the narrow bandgap region [(4, 40)] is located at the edge of the main avalanche region [(10, 46)].

4. *(Amended)* An IMPATT diode according to [any one of the preceding claims]claim 1, wherein the narrow bandgap region [(4)] is located between a heavily doped contact region [(8)] and the main avalanche region [(10)].

5. *(Amended)* An IMPATT diode according to [any one of the preceding claims]claim 1, wherein the narrow bandgap region [(4, 40)] comprises one layer of narrow bandgap material.

6. *(Amended)* An IMPATT diode according to [any one of claims 1 to 4]claim 1, wherein the narrow bandgap region [(4, 40)] comprises a plurality of layers of narrow bandgap material.

7. *(Amended)* An IMPATT diode according to [any one of the preceding claims]claim 1, wherein the diode has a lo-hi-lo doping profile.

9. *(Amended)* An IMPATT diode according to [any one of claims 1 to 6]claim 1, wherein the diode is a double drift diode.

10. *(Amended)* An IMPATT diode according to [any one of the preceding claims]claim 1, wherein the diode is made of III-V semiconductor materials.

11. *(Amended)* An IMPATT diode according to [any one of claims 1 to 7]claim 1, wherein the diode is made of group IV semiconductor materials.

12. *(Amended)* An IMPATT diode according to claim 11 wherein the narrow bandgap region [(4, 40)] is made of at least one layer of Silicon Germanium and the main avalanche region [(10, 46)] is made of Silicon.

13. *(Amended)* An IMPATT diode according to claim 10 wherein the narrow bandgap region [(4, 40)] is made of at least one layer of Gallium Arsenide and the main avalanche region [(10, 46)] is made of Aluminium Gallium Arsenide.

14. *(Amended)* An IMPATT diode according to [any one of the preceding claims]claim 1, wherein the length of the drift region or regions [(12, 44, 48)] is between 2 and 6 times the length of the avalanche region [(10, 46)].

15. *(Amended)* An IMPATT diode according to claim 14 wherein the length of the drift region or regions [(12, 44, 48)] is between 3.5 and 4.5 times the length of the avalanche region [(10, 46)].

16. *(Amended)* An IMPATT diode according to [any one of the preceding claimed]claim 1, arranged such that at least part of the tunnel current can be generated by optical excitation.

17. *(Amended)* A method of operating [an] the IMPATT diode [according to any one of the preceding claims]of claim 1, [such that] wherein an oscillating voltage across the diode has a period of between 4 and 12 times the transit time of the avalanche region [(10, 46)].

18. *(Amended)* A method according to claim 17 wherein the oscillating voltage has a period of between 7.5 and 8.5 times the transit time of the avalanche region [(10, 46)].

19. *(Amended)* A method [of operating an IMPATT diode] according to [any one of claims 1 to 17]claim 17 including the step of optically exiting at least part of the tunnel current.